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Title: **Potential Vorticity Index**

Investigators:

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I. Significant Accomplishments in the Past Year

1. Data handling: a synopsis

(1) Dr. Weng attended the NASA Climate Data System (NCDS) Workshop, held at Goddard Space Flight Center, NASA, in October 1989;

(2) Using knowledge gained at that workshop we attempted to use the reanalyzed ECMWF FGGE data through NCDS instead of the original ECMWF FGGE data we used in the past for the SOP periods.

(3) After unpacking the new data we discovered systematic departures from the old data set which caused oscillations in our time series. By February 1990 we reverted to the original ECMWF FGGE data set.

2. Presentation at a meeting

We presented a paper at the XV General Assembly of the European Geophysical Society (April 1990).

3. Publication

We are writing-up a paper to be submitted to Monthly Weather Review in the summer 1990.

4. Research accomplishments

(1) Motivation

Our work was motivated by the success of "Isentropic Potential Vorticity (IPV) thinking". Using these concepts, we propose to describe dynamical processes as well as interactions between atmospheric action centers (Hoskins et al., 1985; Haynes and McIntyre, 1987)

(2) Main themes of research

Using standard data analysis techniques, we propose to explore the links between:

a. disturbance growth and quasi-geostrophic PV gradients;

b. appearance and disappearance of cutoff lows and blocking highs and their relation to a zonal index (properly defined in terms of PV);

c. teleconnections between different flow patterns and their relation to the zonal index.

(3) Data analyses

The FGGE Level IIIb analyses made by ECMWF for the winter period of Dec 1, 1978 – Feb 28, 1979 (twice/day) are used for this study. All data at $1.875° \times 1.875°$ latitude -longitude grid points between 0 – 90N are used for IPV at $300K$ and geopotential height at $500mb$. A PV index is defined by zonally averaged PV gradient between two latitude belts $60 - 71.25N$ and $33.75 - 41.25N$. We study the correlation between this index and eddy activity in both frequency and time domains.

(4) Main results

a. The PV index and the eddy index correlate better than a zonal index (defined by zonal wind) and the eddy index. In the frequency domain there are three frequencies (.03, .07 and .17 cpd (cycle per day) corresponding to periods of 33, 14 and 6 days) at which the PV index and the eddy index exhibit local maxima. The high correlation found at periods of 33 days is mainly due to eddy activity at high latitudes while the local correlation maxima found at the shorter periods are mainly due mid-latitude eddy activity.

b. The correlation between the PV index and the geopotential height anomaly at $500mb$, at each grid point in the Northern Hemisphere, shows the existence of most of the teleconnection patterns summarized by Wallace and Gutzler (1981): the North Atlantic Oscillation, the North Pacific Oscillation, and the Pacific/North American patterns. The existence and the evolution of these patterns are seen from daily $500mb$ maps during this period. Each pattern has two extreme phases, corresponding to high and low PV index periods, respectively, with a few days' lag. The area over Scandinavia and the Norwegian Sea seems to be a key area which affects global flow changes. The composite maps show that, in general, high and low index periods correspond to "wavy" and "zonal" flow in mid-latitudes, respectively, especially over Europe.

c. Our results show that the IPV analysis can be a very useful and powerful tool when used to understand the dynamics of several large scale atmospheric systems. Although the data are limited to only one winter, and it is difficult to assess the statistical significance of the correlation coefficients presented here, the results are encouraging from physical viewpoint.

II. Focus of Current Research and Plans for Next Year

1. Complete the paper pertaining PV index vacillation in Northern Hemisphere, while trying to understand more about the phenomena physically.

2. Perform EOF analyses of high- and mid-latitude geopotential height anomalies and relate the results with the PV index. The purpose of it is to find possible relationship between blocking and cyclogenesis at different locations with the variation of the PV index.

3. Start a similar research for the FGGE winter in the Southern Hemisphere. The comparison between the results for two hemispheres is very useful for understanding the effect of topography in the Northern Hemisphere.

III. Papers and Presentations Supported by NASA in the Past Year

1. Weng, H.-Y., 1990: The effects of oppositely sloping boundaries with Ekman dissipation in a nonlinear baroclinic system. *Quart. J. Roy. Meteor. Soc.*, **116**, 1 – 29.

2. Weng, H.-Y. and A. Barcilon, 1990: Potential vorticity index and its relation to blocking and cyclogenesis. *XV General Assembly of European Geophysical Society, 23 – 27 April, 1990.*

3. Weng, H.-Y. and A. Barcilon, 1990: Potential vorticity index vacillation. Part I: its relation to teleconnection. To be submitted to *Mon. Wea. Rev.* in August.